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(54) ELECTRICAL GENERATOR

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(57) ABSTRACT

An electrical generator is provided. The electrical generator includes a support, a magnetic material configured to be coupled to the support, and at least one flexible conductive member configured to include an electrical conductor associated with the magnetic material and to move in response to a fluid flow.

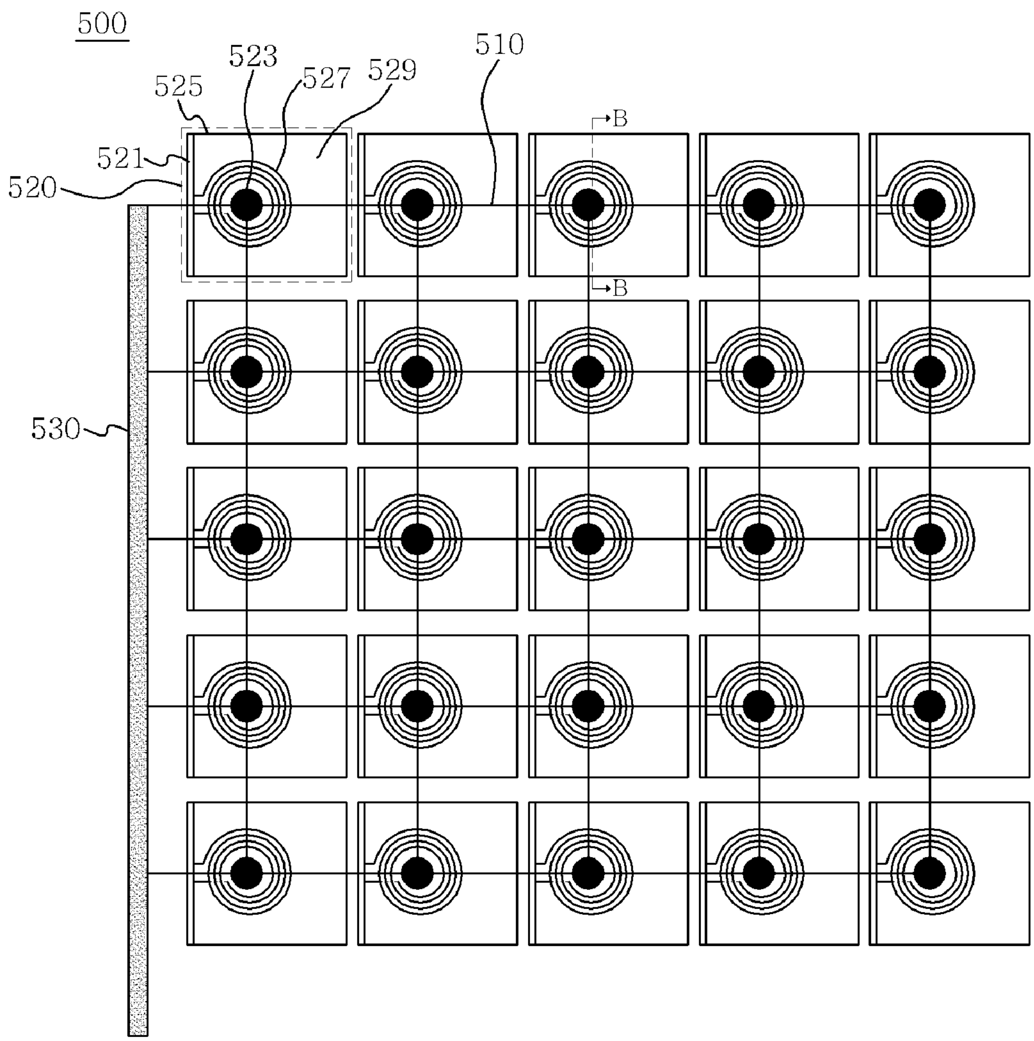


FIG. 1

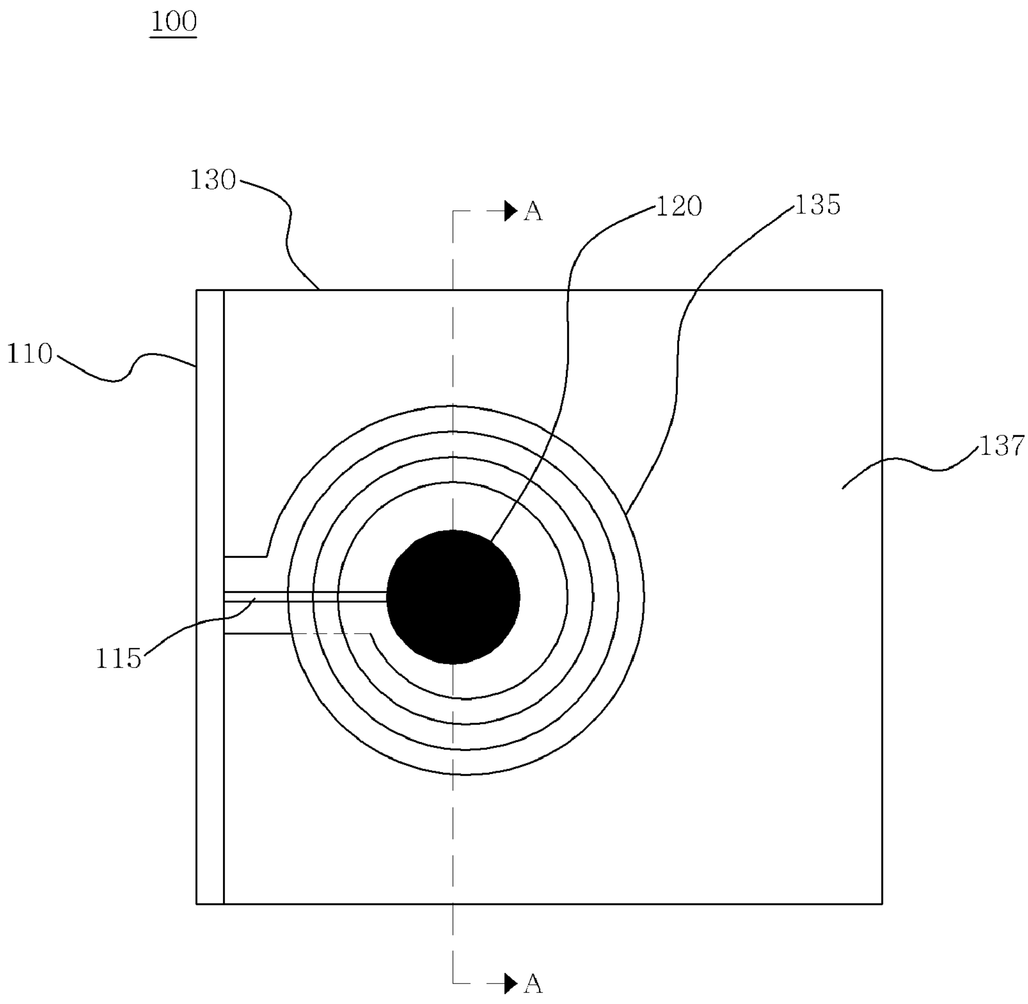


FIG. 2

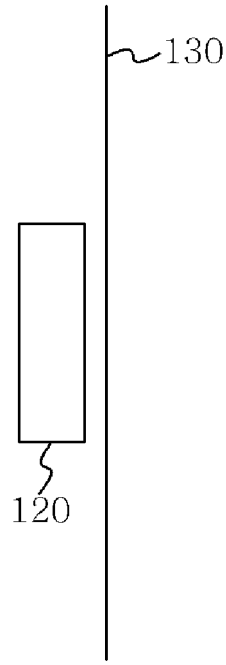


FIG. 3

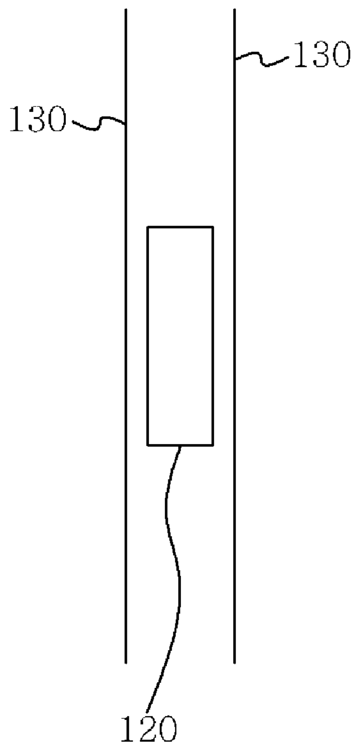


FIG. 4

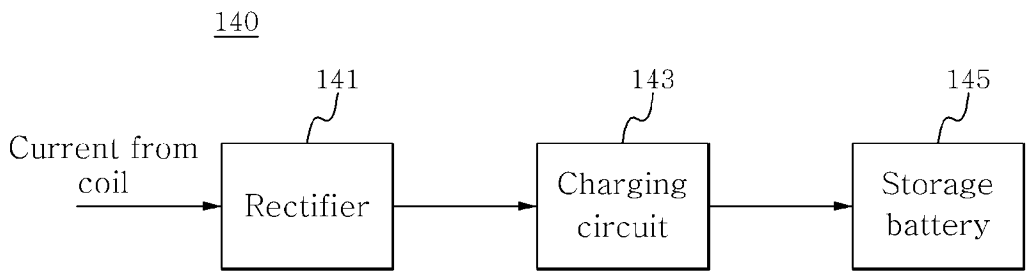

140
141
143
145
Current from coil
Rectifier
Charging circuit
Storage battery

FIG. 5

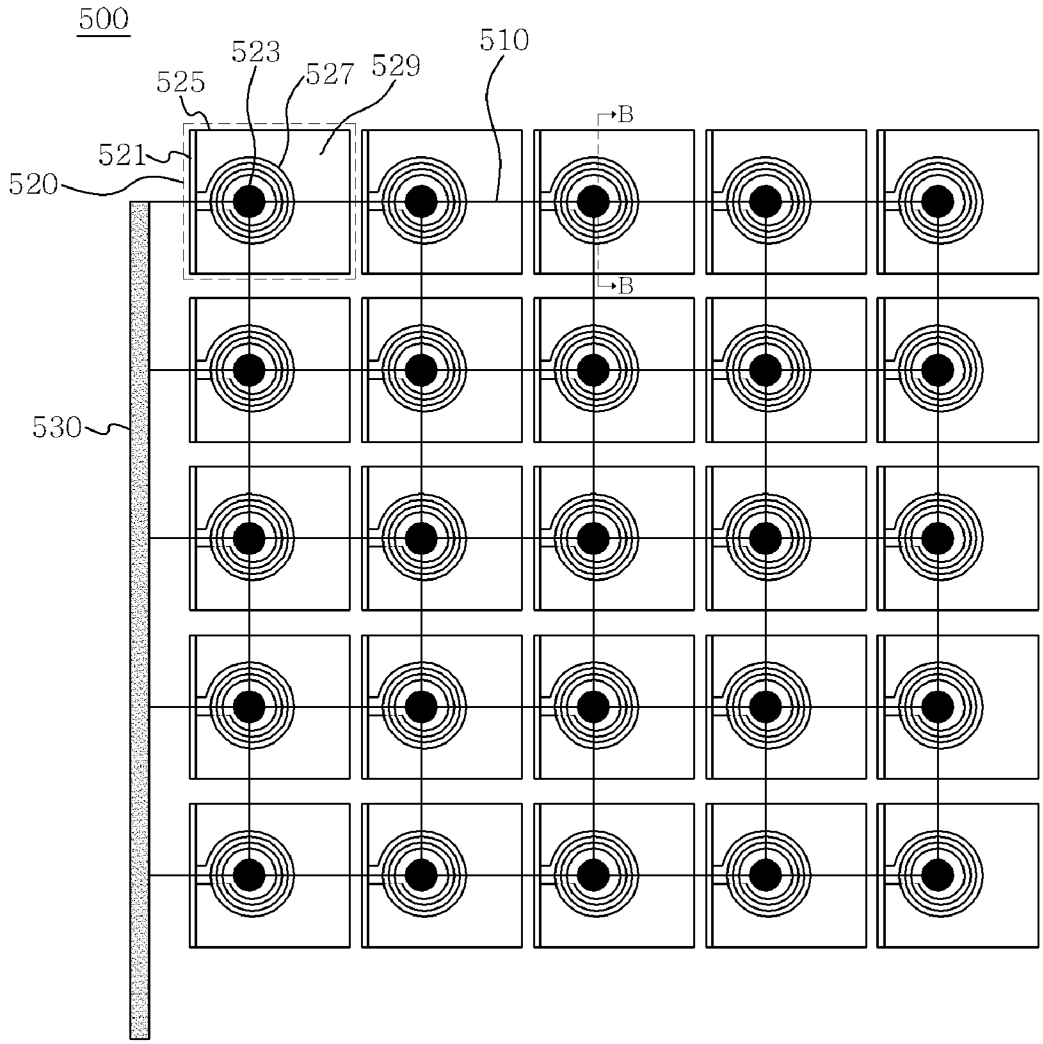


FIG. 6

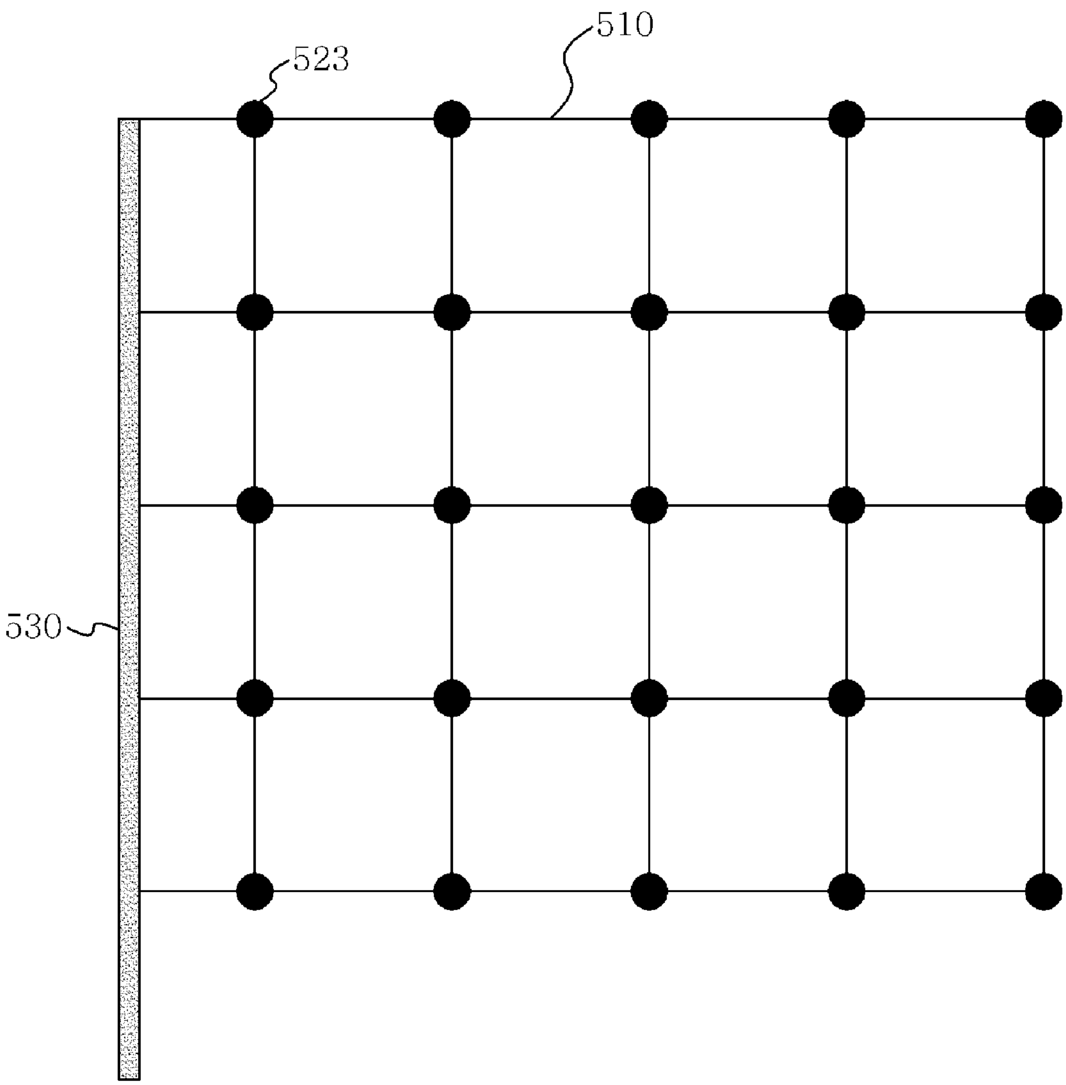
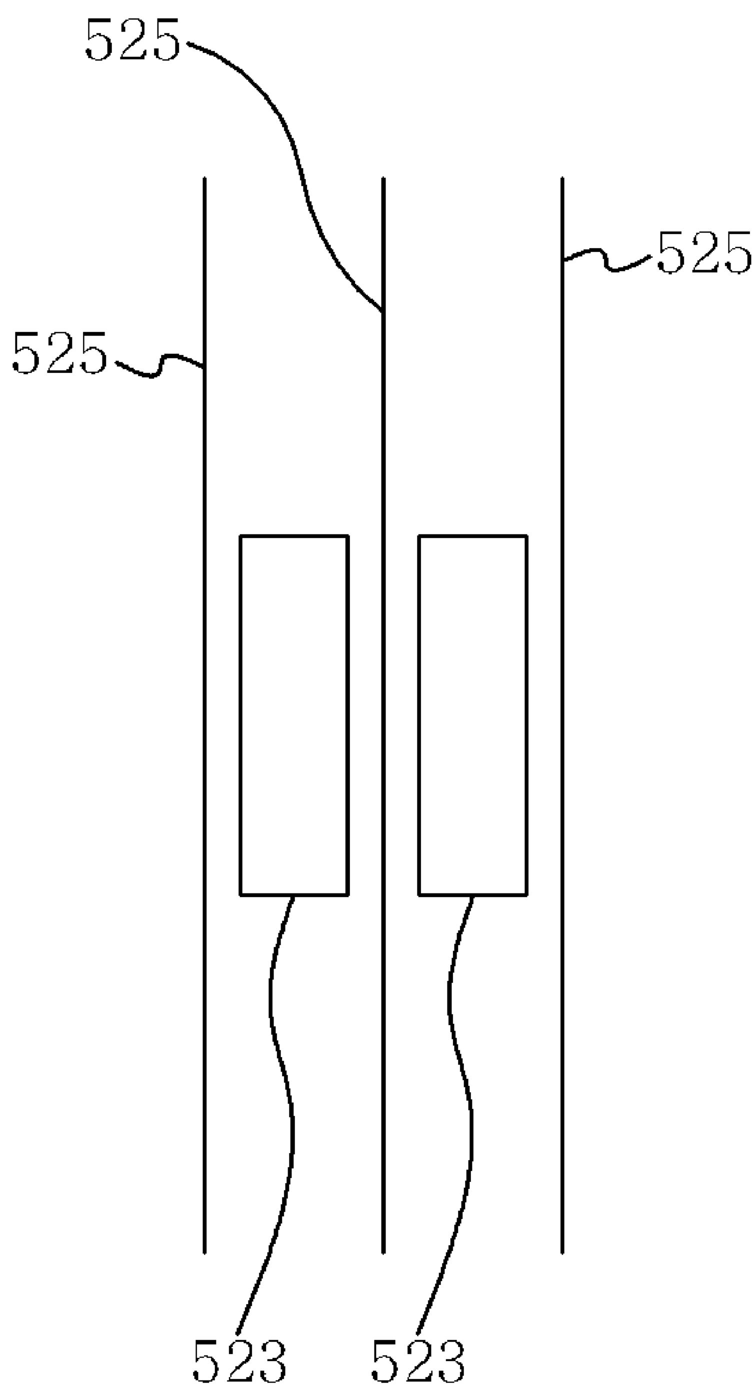


FIG. 7



ELECTRICAL GENERATOR

BACKGROUND

[0001] A wind power has been spotlighted as an attractive replacement to fossil fuel for an environmental reason such as a green house effect. A technique of wind power generation uses rotors to generate an electrical energy by wind. The technique for manufacturing, installing, or maintaining a wind power generator is generally complicated and expensive.

BRIEF DESCRIPTION OF THE FIGURES

[0002] FIG. **1** is a schematic diagram showing an illustrative embodiment of an electrical generator.
[0003] FIG. **2** is a sectional view taken along line A-A shown in FIG. **1**.
[0004] FIG. **3** is another sectional view taken along line A-A shown in FIG. **1**.
[0005] FIG. **4** is a schematic diagram showing an illustrative embodiment of a power circuit storing currents generated by electrical generator shown in FIG. **1**.
[0006] FIG. **5** is a schematic diagram showing another illustrative embodiment of an apparatus to generate an electrical energy.
[0007] FIG. **6** is a schematic diagram of the frame shown in FIG. **5**.
[0008] FIG. **7** is a sectional view taken along line B-B shown in FIG. **5**.

DETAILED DESCRIPTION

[0009] In the following detailed description, reference is made to the accompanying drawings, which form a part hereof. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative embodiments described in the detailed description, drawings, and claims are not meant to be limiting. Other embodiments may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented herein. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, separated, and designed in a wide variety of different configurations, all of which are explicitly contemplated herein.

[0010] In one illustrative embodiment, an electrical generator includes a support, a magnetic material configured to be coupled to the support, and at least one flexible conductive member configured to include an electrical conductor associated with the magnetic material and to move in response to a fluid flow. An end of the at least one flexible conductive member is coupled to the support.

[0011] FIG. **1** is a schematic diagram showing an illustrative embodiment of an electrical generator. FIG. **2** is a sectional view taken along line A-A shown in FIG. **1**. FIG. **3** is another sectional view taken along line A-A shown in FIG. **1**.

[0012] FIG. **1** illustrates that an electrical generator **100** includes a support **110**, a magnetic material **120** configured to be coupled to support **110**, and at least one flexible conductive member **130** configured to include an electrical conductor **135** associated with magnetic material **120** and a flexible film **137** moving in response to a fluid flow such as water flow, tidal flow, or air flow (e.g. wind). FIG. **1** further illustrates that one end of the at least one flexible conductive member **130** is coupled to support **110**. For example, a left end (or right, upper or lower end) of the at least one flexible conductive member **130** may be wrapped around support **110**, or inserted in a groove (not shown) formed in support **110**.

[0013] Support **110** may be configured to support magnetic material **120** and at least one flexible conductive member **130**. Support **110** may be made of any metal or metal compound such as steel, iron, copper, aluminum, magnesium, or their alloy, also any plastic such as polyethylene, polypropylene, polyvinyl chloride, polystyrene, polyethylene terephthalate, or acrylonitrile-butadiene-styrene resin, or wood, etc.

[0014] In one embodiment, support **110** may have a shape of rod or bar. In this case, support **110** may include a branch **115** configured to couple to magnetic material **120**. Branch **115** may be made of the same material as support **110**. For example, the length of branch **115** may be more or less than approximately 10, 15, or 20 centimeter (cm), and the thickness of branch **115** may be more or less than approximately 1, 2, or 3 cm, but not limited thereto. Branch **115** may be coupled to support **110** or formed together with support **110** in one body. For example, branch **115** may be formed by being inserted into a hole formed on the surface of support **110**. By way of another example, one end of branch **115** may have a C-shaped or O-shaped inner space in which support **110** can be inserted. By way of still another example, support **110** may be configured to have a protrusion on a portion of its surface and the protrusion may be elongated in perpendicular to the longitudinal direction of support **110** to form branch **115**. A free end of branch **115** may be coupled to magnetic material **120**. For example, the free end of branch **115** may be coupled to magnetic material **120** by using an adhesive or formed to have a C-shaped or O-shaped inner space so that magnetic material **120** is inserted in the space, but not limited thereto. In another embodiment, support **110** may be a board having the shape of a triangle, a tetragon, or a pentagon, etc. In this case, support **110** may have a hole or recess (not shown) so that magnetic material **120** is inserted in the hole or recess. Although FIG. **1** illustrates that support **110** may be the same size as at least one flexible conductive member **130**, it is apparent to those skilled in the art that support **110** may be bigger or smaller than at least one flexible conductive member **130**.

[0015] Magnetic material **120** may be configured to include a permanent magnet to generate a magnetic field. For example, magnetic material **120** may be paramagnetic, ferromagnetic, ferrimagnetic, or diamagnetic material, etc. The diameter of magnetic material **120** may be, for example, less than approximately 10, 15, or 20 cm, but not limited thereto. FIG. **1** illustrates that magnetic material **120** has a circular shape, but not limited thereto, magnetic material **120** may have a square or rectangular shape and so on.

[0016] Flexible film **137** may be configured to generate a movement in response to the fluid flow, such as wind. By way of examples, flexible film **137** may include vinyl material (such as polyvinyl chloride, low-density polyethylene, polypropylene, and ethylene vinyl acetate), paper, or fabric, etc., without limitation. Flexible film **137** may be configured to move when subject to the fluid flow such as wind. Here, the term “movement” of flexible film **137** refers to vibrating, waving, shaking, oscillating, flapping, or fluttering of flexible film **137**. By way of example, one free side of flexible film **137** may move up and down or from side to side with small movements (e.g., high or low amplitude or frequency), while an opposite side of flexible film **137** is held in support **110**. In one embodiment, flexible film **137** can be extended and move in the air flow, e.g., the wind having a speed more than 12 km/h. It is well known to those skilled in the art that, at the wind speed range corresponding to level three of the Beaufort wind force scale is 12 to 19 km/h, small objects (e.g., tree leaves, small twigs, or flag) can constantly move and be extended.

[0017] In one embodiment, flexible film **137** may be configured to have a size appropriate for moving in the fluid flow. For example, the size of flexible film **137** may be 20 by 15 cm, 25 by 20 cm, or 30 by 25 cm, but not limited thereto. Flexible film **137** may have a square, rectangular, or triangular shape, without limitation.

[0018] Electrical conductor **135** may be configured to be conductively or electromagnetically coupled to magnetic material **120**. Electrical conductor **135** may not necessarily contact magnetic material **120**. For example, electrical conductor **135** may be configured to surround magnetic material **120**. Particularly, electrical conductor **135** may have a shape such that a current can be generated by relative movement of electrical conductor **135** with respect to magnetic material **120**. The relative movement and the generation of the current will be described in detail hereinafter. By way of example, FIG. **1** illustrates that a coil shape of electrical conductor **135** surrounds magnetic material **120** having a circular shape. By way of another example, electrical conductor **135** may have a square or rectangular shape to surround magnetic material **120** having a square or rectangular shape. It is apparent to those skilled in the art that the shape of electrical conductor **135** can be variable depending on the shape of magnetic material **120**.

[0019] In one embodiment, electrical conductor **135** may include conductive material such as metal (such as copper, silver, and aluminum, etc.) or conductive ink made of metallic particles such as silver or copper flakes, or carbon flakes/particles. Electrical conductor **135** may be a conductive ink printed on flexible film **137** in a coil shape or a coil-shaped thin film of copper or aluminum attached on flexible film **137**. For example, electrical conductor **135** may be formed by printing the conductive ink on flexible film **137** in a coil shape, or by attaching a coil made from a thin film of copper or aluminum on flexible film **137**. However, it is not limited thereto. The diameter of the coil may be, for example, more or less than approximately 10, 15, or 20 cm, but not limited thereto.

[0020] As described above, magnetic material **120** may be associated with electrical conductor **135** of at least one flexible conductive member **130** without contacting electrical conductor **135**. By way of example, FIG. **2** illustrates magnetic material **120** facing one surface (e.g., a front or rear surface) of at least one flexible conductive member **130**. Although not shown in FIG. **2**, magnetic material **120** may be placed to be adjacent to electrical conductor **135** of at least one flexible conductive member **130**. By way of examples, magnetic material **120** and electrical conductor **130** may be placed in parallel to each other.

[0021] In some embodiments, magnetic material **120** may be placed between two flexible conductive members **130**. By way of examples, FIG. **3** illustrates a pair of flexible conductive members **130** are positioned such that each flexible conductive member faces each surface of magnetic material **120**. Although FIGS. **2** and **3** illustrate that at least one flexible conductive member **130** may be configured to be spaced apart from magnetic material **120**, it is apparent to those skilled in the art that at least one flexible conductive member **130** and magnetic material **120** may be configured to contact to each other.

[0022] In one embodiment, support **110** may be coupled to an immovable object, such as a ground, a building or any structure capable of supporting or holding support **110**. Bearings (not shown) may be interposed between support **110** and the immovable object for supporting support **110** and enabling support **110** to rotate with respect to the immovable object. Since support **110** can freely rotate although it is coupled to the immovable object, at least one flexible conductive member **130** associated with support **110** can be free to rotate in the direction of the fluid flow.

[0023] When flexible film **137** is subject to the fluid flow, for example, it moves from side to side repeatedly, and, then, electrical conductor **135** disposed on flexible film **137** can move according to the movement of flexible film **137**. The movement of electrical conductor **135** may include vibrating, oscillating, waving, or shaking, etc. The movement of electrical conductor **135** caused by the fluid flow changes the position of electrical conductor **135** relative to magnetic material **120**. Here, the term "relative position" of electrical conductor **135** refers to variable position of electrical conductor **135** with respect to magnetic material **120**. The changes of relative position of electrical conductor **135** affects the magnetic field experienced by electrical conductor **135**, which in turn changes magnetic flux acting on electrical conductor **135** and induces current on electrical conductor **135** according to Faraday's law of induction, which is well known to those skilled in the art.

[0024] In one embodiment, electrical generator **100** may further include a power circuit **140** shown in FIG. **4**. FIG. **4** is a schematic diagram showing an illustrative embodiment of power circuit **140** storing currents generated by electrical generator **100**.

[0025] FIG. **4** illustrates that power circuit **140** includes a rectifier **141**, a charging circuit **143**, and a storage battery **145** that are connected in sequence. Rectifier **141** may receive the alternating current (AC) generated by electrical conductor **135** and convert the AC into direct current (DC). In one embodiment, rectifier **141** may be made in a chip and mounted in at least one flexible conductive member **130**, but not limited thereto.

[0026] Charging circuit **143** generates charging current using the DC from rectifier **141** and supplies the charging current to storage battery **145**. In one embodiment, charging circuit **143** may include a smoothing circuit (not shown) that smoothes the DC from rectifier **141** and a filter (not shown) that removes noise from the DC supplied by rectifier **141**.

[0027] Storage battery **145** may store the charging current supplied from charging circuit **143**. In one embodiment, storage battery **145** may be connected to various electronic applications to supply power. Storage battery **145** may be any kind of batteries and may have any level of output voltage.

[0028] Power circuit **140** may be provided inside support **110**, but not limited thereto, all or part of power circuit **140** may be located outside support **110**.

[0029] In one embodiment, electrical generator **100** may use a variety of fluid flow such as water flow and tidal flow as well as air flow. Electrical generator **100** may be placed under the river or the ocean. In this case, at least one flexible conductive member **130** moves by the water flow or the tidal flow and then electrical conductor **135** moves. Therefore, electrical generator **100** can generate current in the water flow or the tidal flow in the substantially same way electrical generator **100** generates current in air flow such as wind.

[0030] Electrical generator **100** may be manufacture with low cost and may be also adaptable to small fluid flow power due to the simple structure and the small size of electrical generator **100** as shown in FIG. **1**. In addition, electrical generator **100** may be easily installed, for example, by inserting support **110** into a hole formed on the immovable object, and use as well as easy maintenance and repair.

[0031] In another illustrative embodiment, two or more electrical generators may be used to generate an electrical energy. By way of examples, a plurality of electrical generators may be arranged on one frame to generate an electrical energy in response to a fluid flow applied to the frame. Each of the electrical generators may include a magnetic material and at least one flexible conductive member, as described above with respect to FIG. **1**. Such embodiment will be described in detail hereinafter with respect to FIGS. **5**-**7**.

[0032] FIG. **5** is a schematic diagram showing another illustrative embodiment of an apparatus to generate an electrical energy. FIG. **6** is a schematic diagram of the frame shown in FIG. **5**. FIG. **7** is a sectional view taken along line B-B shown in FIG. **5**.

[0033] FIG. **5** illustrates that an apparatus **500** includes multiple electrical generators **520** arranged on a frame **510** in a matrix, for example, a 5×5 matrix. Although FIG. **5** illustrates 5×5 matrix arrangement, it is apparent to those skilled in the art that frame **510** can have different matrix-arrangement, such as a 3×3 matrix or 6×6 matrix, depending on a desired layout. FIG. **5** further illustrates that each electrical generator **520** includes a support **521** (for example, first support), a magnetic material **523**, and at least one flexible conductive member **525** configured to be coupled to first support **521**. FIG. **5** still further illustrates that at least one flexible conductive member **525** includes an electrical conductor **527** electrically associate with magnetic material **523** and a flexible film **529** moving in response to the fluid flow.

[0034] Since each electrical generator **520** is substantially similar or identical to electrical generator **100**, the detailed description for the similar or identical parts will be omitted for the simplicity of the description.

[0035] In one embodiment, frame **510** may be made of any metal or metal compound such as steel, iron, copper, aluminum, magnesium, or their alloy, any plastic such as polyethylene, polypropylene, polyvinyl chloride, polystyrene, polyethylene terephthalate, or acrylonitrile-butadiene-styrene resin, or wood, without limitation, and be one of a net-type frame and a jungle gym-type frame. For example, FIGS. **5** and **6** illustrate a net-type frame **510** having five columns and five rows, but not limited thereto.

[0036] In one embodiment, each magnetic material **523** may include a permanent magnet to generate a magnetic field and magnetic materials **523** may be spaced apart from each other. FIGS. **5** and **6** illustrate that magnetic materials **523** are disposed on intersections of frame **510** such that each magnetic material **523** can be electrically associated with at least one flexible conductive member **525**. The intersections of frame **510** may be formed to have a C-shaped or O-shaped inner space so that magnetic material **523** is inserted in the space, but not limited thereto. FIGS. **5** and **6** further illustrate that magnetic materials **523** are arranged in a 5×5 matrix, but not limited thereto, and the number of magnetic materials **523** may be more or less according to a desired capacity of power generation. In another embodiment, magnetic material **523** may be coupled to not frame **510** but first support **521**. In this case, first support **521** may include a branch (not shown) like branch **115** shown in FIG. **1**, and magnetic material **523** may be coupled to the branch, as described above.

[0037] In one embodiment, flexible film **529** may be configured to generate a movement in response to the fluid flow. Flexible film **529** may include vinyl material, paper, or fabric, without limitation, as described above.

[0038] In one embodiment, electrical conductor **527** may include conductive material such as metal or conductive ink and be a conductive ink printed on flexible film **529** in a coil shape or a coil-shaped thin film of copper or aluminum attached on flexible film **529**, as described above. Electrical conductor **527** may move according to the movement of flexible film **529** in the fluid flow.

[0039] In one embodiment, first support **521** may be made of metal, plastic, or wood, without limitation, and coupled to an end of at least one flexible conductive member **525**. First support **521** may be coupled to frame **510**. In the embodiment that magnetic material **523** is coupled to the intersection of frame **510**, first support **521** is coupled to frame **510** such that at least one flexible conductive member **525** can face or be adjacent to magnetic material **523**, and, thus, at least one flexible conductive member **525** can be electrically associated with magnetic material **523**. By way of example, at least a portion of first support **521** may be coupled to frame **510** by a fastener such as bolt, nut, and screw, without limitation. A variety of methods may be used to attach first support **521** to frame **510**. In one embodiment, first support **521** may have a structure (such as buckle, clip, or groove joint structure) that can be detachably attached to frame **510**. For example, frame **510** and first support **521** may be formed to have a groove or recess and a protrusion, respectively. Therefore, first support **521** can be detachably attached to frame **510** by pushing the protrusion in the groove or recess and by picking the former out of the latter. Since electrical generator **520** is coupled to frame **510** by first support **521**, a disabled electrical generator can be easily replaced with a new one by using the detachable first support.

[0040] In one embodiment, apparatus **500** may further include a support **530** (for example, second support) configured to couple to frame **510** by a fastener or welding. By way of examples, FIG. **6** illustrates that second support **530** is coupled to a portion of frame **510** in a column direction. Second support **530** may be made of any metal or metal compound such as steel, iron, copper, aluminum, magnesium, or their alloy, any plastic such as polyethylene, polypropylene, polyvinyl chloride, polystyrene, polyethylene terephthalate, or acrylonitrile-butadiene-styrene resin, or wood, without limitation. In one embodiment, one or more electrical cables may be provided inside or outside frame **510** and second support **530** to electrically connect electrical conductors **527** to a power circuit (for example, **140** shown in FIG. **4**). Second support **530** may be coupled to an immovable object, such as a ground, a building or any structure capable of supporting or holding second support **530**. Bearings (not shown) may be interposed between second support **530** and the immovable object for supporting second support **530** and enabling second support **530** to rotate. Therefore, frame **510** can be free to rotate to follow the direction of the fluid flow when the fluid flow direction changes.

[0041] In one embodiment, apparatus **500** may further include a power circuit, such as power circuit **140** shown in FIG. **4**. As described above, power circuit **140** may include a plurality of rectifiers **141**, a charging circuit **143**, and a storage battery **145** that are connected in sequence. In this case, each rectifier **141** may be mounted in each flexible conductive member **525**, but not limited thereto, rectifiers **141** may be attached to frame **510** or first supports **521**. Each rectifier **141** may be connected to respective electrical conductor **527**.

[0042] In one embodiment, two or more flexible conductive members **525** may be alternately stacked in series. By way of examples, FIG. **7** illustrates that electrical generator **520** includes three flexible conductive members **525** and two magnetic materials **523**. Particularly, three flexible conductive members **525** may be stacked in series such that each magnetic material **523** may be interposed between two adjacent flexible conductive members **525**. In this case, three flexible conductive members **525** may be coupled to three first supports **521** respectively and three first supports **521** may be connected each other. Thus, three or more magnetic materials **523** may be also stacked such that each magnetic material **523** may be interposed between two adjacent flexible conductive members **525**. Accordingly, the number of flexible conductive members **525** is greater than the number of magnetic materials **523** by one. Since the stacked structure of electrical generator **100** provides the increased number of magnetic materials **523** and flexible conductive members **525** on a given area, an increased power generation capacity can be provided to various fields, such as home, factory, leisure industry, etc.

[0043] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[0044] It will be understood by those within the art that, in general, terms used herein, and especially in the appended claims (e.g., bodies of the appended claims) are generally intended as "open" terms (e.g., the term "including" should be interpreted as "including but not limited to," the term "having" should be interpreted as "having at least," the term "includes" should be interpreted as "includes but is not limited to," etc.). It will be further understood by those within the art that if a specific number of an introduced claim recitation is intended, such an intent will be explicitly recited in the claim, and in the absence of such recitation no such intent is present. For example, as an aid to understanding, the following appended claims may contain usage of the introductory phrases "at least one" and "one or more" to introduce claim recitations. However, the use of such phrases should not be construed to imply that the introduction of a claim recitation by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim recitation to embodiments containing only one such recitation, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an" (e.g., "a" and/or "an" should be interpreted to mean "at least one" or "one or more"); the same holds true for the use of definite articles used to introduce claim recitations. In addition, even if a specific number of an introduced claim recitation is explicitly recited, those skilled in the art will recognize that such recitation should be interpreted to mean at least the recited number (e.g., the bare recitation of "two recitations," without other modifiers, means at least two recitations, or two or more recitations). Furthermore, in those instances where a convention analogous to "at least one of A, B, and C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, and C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). In those instances where a convention analogous to "at least one of A, B, or C, etc." is used, in general such a construction is intended in the sense one having skill in the art would understand the convention (e.g., "a system having at least one of A, B, or C" would include but not be limited to systems that have A alone, B alone, C alone, A and B together, A and C together, B and C together, and/or A, B, and C together, etc.). It will be further understood by those within the art that virtually any disjunctive word and/or phrase presenting two or more alternative terms, whether in the description, claims, or drawings, should be understood to contemplate the possibilities of including one of the terms, either of the terms, or both terms. For example, the phrase "A or B" will be understood to include the possibilities of "A" or "B" or "A and B."

[0045] In addition, where features or aspects of the disclosure are described in terms of Markush groups, those skilled in the art will recognize that the disclosure is also thereby described in terms of any individual member or subgroup of members of the Markush group.

[0046] As will be understood by one skilled in the art, for any and all purposes, such as in terms of providing a written description, all ranges disclosed herein also encompass any and all possible subranges and combinations of subranges thereof. Any listed range can be easily recognized as sufficiently describing and enabling the same range being broken down into at least equal halves, thirds, quarters, fifths, tenths, etc. As a non-limiting example, each range discussed herein can be readily broken down into a lower third, middle third and upper third, etc. As will also be understood by one skilled in the art all language such as "up to," "at least," and the like include the number recited and refer to ranges which can be subsequently broken down into subranges as discussed above. Finally, as will be understood by one skilled in the art, a range includes each individual member. Thus, for example, a group having 1-3 cells refers to groups having 1, 2, or 3 cells. Similarly, a group having 1-5 cells refers to groups having 1, 2, 3, 4, or 5 cells, and so forth.

[0047] From the foregoing, it will be appreciated that various embodiments of the present disclosure have been described herein for purposes of illustration, and that various modifications may be made without departing from the scope and spirit of the present disclosure. Accordingly, the various embodiments disclosed herein are not intended to be limiting, with the true scope and spirit being indicated by the following claims.

1. An electrical generator comprising:

a support;

a magnetic material configured to be coupled to the support; and

at least one flexible conductive member configured to include an electrical conductor associated with the magnetic material and to move in response to a fluid flow,

wherein an end of the at least one flexible conductive member is coupled to the support.

2. The electrical generator of claim **1**, wherein the at least one flexible conductive member is configured to be apart from the magnetic material.

3. The electrical generator of claim **1**, wherein the at least one flexible conductive member is configured to further include a flexible film on which the electrical conductor is placed.

4. The electrical generator of claim **3**, wherein the flexible film includes vinyl material, paper, or fabric.

5. The electrical generator of claim **1**, wherein the electrical conductor includes a conductive ink printed on the at least one flexible conductive member in a coil shape or a coil-shaped thin film of copper or aluminum attached on the at least one flexible conductive member.

6. The electrical generator of claim **1**, further comprising a bearing configured to be interposed between the support and an immovable object.

7. The electrical generator of claim **1**, further comprising a rectifier configured to be connected to the electrical conductor; and

a storage battery configured to store an output current of the rectifier.

8. The electrical generator of claim **1**, wherein the fluid flow is at least one of air flow, water flow, and tidal flow.

9. An apparatus to generate an electrical energy comprising:

a frame; and

a plurality of electrical generators arranged on the frame and configured to generate an electrical energy in response to a fluid flow,

wherein each of the electrical generators includes a magnetic material and at least one flexible conductive member, and

wherein the at least one flexible conductive member is configured to be associated with the magnetic material.

10. The apparatus of claim **9**, wherein the at least one flexible conductive member includes a flexible film configured to move in response to the fluid flow and an electrical conductor disposed on the flexible film and configured to change a relative location with the magnetic material in response to the movement of the flexible film.

11. The apparatus of claim **10**, wherein the electrical conductor is configured to include a conductive ink printed on the at least one flexible conductive member in a coil shape or a coil-shaped thin film of copper or aluminum.

12. The apparatus of claim **10**, further comprising a rectifier configured to be connected to the electrical conductor; and

a storage battery configured to store an output current of the rectifier.

13. The apparatus of claim **9**, further comprising a support configured to support the frame.

14. The apparatus of claim **13**, further comprising a bearing configured to be interposed between the support and an immovable object.

15. The apparatus of claim **9**, wherein each of the electrical generators further includes a support configured to be coupled to an end of the at least one flexible conductive member.

16. The apparatus of claim **15**, wherein the support is configured to be attachable to the frame.

17. The apparatus of claim **15**, wherein the magnetic material is configured to be coupled to one of the support and the frame.

18. The apparatus of claim **9**, wherein the magnetic materials and the at least one flexible conductive members are alternately stacked in series.

19. The apparatus of claim **18**, wherein the number of the at least one flexible conductive members is greater than the number of the magnetic materials by one.

20. The apparatus of claim **9**, wherein the electrical generators are arranged on the frame in a matrix.

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